program code for determining boundary cubes from said leaves; and

program code for triangulating a group of at least three of said boundary cubes according to predefined rules.

Remarks

Claims 1-38 are pending. In the Office Action, Claims 1 and 5-8 are rejected under 35 USC 102(b) as being anticipated by Finnigan US Patent No. 5,345,490 that is referred to hereinafter as Finnigan. Claims 2-3 are rejected under 35 USC 103(a) as being unpatentable over Finnigan in view of Migdal et al US Patent No. 5,991,437. Claims 9, 11-14 are rejected under 35 USC 103(a) as being unpatentable over Finnigan in view of Weng et al US Patent No. 6,081,273. Claims 4, 10, 21, 27, 37-38 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the base claim and any intervening claims. Claims 15-17 and 32-34 are allowed.

In the foregoing amendments, Claims 1, 6-7, 18 and 23-24 have been amended. Reconsideration of the rejected claims is respectfully requested based on the following remarks.

The reference to FIG. 6C has been removed, accordingly, the objection to the drawings is believed to have overcome.

Finnigan discloses a system for converting computed tomography (CT) data into finite element models by scanning an object to be modeled with a scanning apparatus 10 (see FIG. 1) and the corresponding description thereof between line 57 of Col. 2 and line 6 of Col. 3. The scanning apparatus 10 is stationed at one position with respect to the object and thus generates images of slices through the cross-section of the object.

Claim 1 recites:

receiving from a camera a sequence of images taken sequentially and respectively around the object;

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generating a 3D region from a sequence of <u>mask images</u>, each of said mask images derived from one of said sequence of images <u>by projecting the object onto a specific plane</u>;
generating a mesh model from said 3D region using a tree structure; and producing said fully-textured 3D model from said mesh model with respect to said sequence of images.

(*emphasis added*)

Evidently, the images, also referred to as surrounding images, are entirely different from that of Finnigan. In other words, the camera and the object in the present invention must be moved around or rotated with respect to each other in order to produce the surrounding images (see FIG. 4). Finnigan does not teach or suggest the creation and use of the surrounding images. Further, Finnigan does not teach or even suggest <u>the use of mask images as well as generating a fully-textured 3D model as recited in Claim 1</u>. The Applicant wishes to point out that a fully-textured 3D model as recited is substantially different from the 3D model of an object in Finnigan. If an object keeps the same shape but changes from one color to another on its surface, the 3D model of the object remains the same in Finnigan but reflects the change in the present invention. Accordingly, the Applicants believe Claims 1 and 5-8 shall be allowable over Finnigan and respectfully request the Examiner to reconsider Claims 1 and 5-8.

Regarding the calibration target, Migdal requires that the calibration target contains geometric shapes (see FIG 1 or FIG. 2 of Migdal) for calibration while the calibration target in the present invention does not have such requirement. Together with the features recited in Claim 1, the Applicants believe Claims 2-3 shall be allowable over Finnigan in view of Migdal and respectfully request the Examiner to reconsider Claims 2-3.

Claim 9 is rejected under Finnigan in view of Weng. However, Claim 9 depends on Claims 8, 7, 6 and 5. The combined features recited in the claims, such as "carving said cubes recursively to fit said object by projecting said cubes against each of said mask images" and "while said carving said cubes recursively proceeds, till a predefined degree of refinement" are neither taught nor suggested in Finnigan or Weng, viewed singly or in combination. Again, Finnigan does not teach or suggest

the use of mask images. A mask image is very different from the images takes from the object. As recited in Claim 1, a mask image is generated from a side view image by projecting an object onto a specific plane. Accordingly, together with the features recited in Claim 1 and the intervening claims, the Applicants believe Claims 9 and 11-14 shall be allowable over Finnigan in view of Weng and respectfully request the Examiner to reconsider Claims 9, and 11-14.

Claims 18-20, 22-26, 28-31 and 35-36 are rejected with similar reasons. The Applicants wishes to apply the above reasons to support these claims and respectfully request the Examiner to reconsider Claims 18-20, 22-26, 28-31 and 35-36 in view of the remarks herein.

The Applicant appreciates the Examiner for allowing Claims 15-17 and 32-34. In view of the above amendments and remarks, the Applicant believes that Claims 1-14, 18 – 31 and 35-38 shall be in condition for allowance. Therefore, it is believed that the entire application is now in condition for allowance, early and favorable action is being respectfully solicited.

PTO FORM-2038 is enclosed for extension to reply within one month.

If there are any issues remaining which the Examiner believes could be resolved through either a Supplementary Response or an Examiner's Amendment, the Examiner is respectfully requested to contact the undersigned at (408)777-8873.

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to "Commissioner of Patents and Trademarks, Washington, DC 20231", on July 22, 2002. (Faxed to (703)872-9314)

Name: Joe Zheng
Name
Signature: JZheng

Respectfully submitted;

JZheng

Joe Zheng
Reg.: No. 39,450

Version with markings to show changes made

In the Specification

1. The following paragraph replaces the original paragraph that begins line 15 and ends line 23 of page 4 of the Specification:

> Another commonly used 3D modeling approach is a stereoscopic system employing one or more imaging systems located at known locations or distances from each other to take multiple images of a 3D object. The captured images are processed with a pattern recognition system that corresponds to the various points of the object in the multiple images and triangulates to extract depth information of these points, thereby obtaining the shape/contour information of the 3D object.

2. Delete the original paragraph that begins line 10 and ends line 12 of page 10 of the Specification:

> [**Figure 6C** shows an exemplary collection of "black" cubes (3D region) defines a volumetric boundary of the object in a 3D space;]

3. The following paragraph replaces the original paragraph that begins line 22 and ends line 23 of page 10 of the Specification:

Figure[s] 9 shows a meshing process flowchart according to one embodiment of the present invention;

4. The following paragraph replaces the original paragraph that begins line 7 and ends line 9 of page 19 of the Specification:

According to one aspect of the present invention, an observation from the distortions of shape **222** provides the following properties:

5. The following paragraph replaces the original paragraph that begins line 11 and ends line 14 of page 21 of the Specification:

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Based on the known geometry of the calibration disk and the measured major axes [a] and minor axes **224-227** along with the above three properties, a computation process can be constructed to estimate uniquely the following parameters at **312**:

6. The following paragraph replaces the original paragraph that begins line 18 of page 16 and ends line 3 of page 27 of the Specification:

There are now *n* object images and a corresponding number of respective mask images derived from side view images (C1, C2 ... Cn). As each of the mask images is a projection of the 3D object onto a specific 2D plane[;], the group of the mask images inherently constrains a 3D region in which the 3D object exists. Hence a volumetric analysis [is] now proceed[ed]s along with the respective mask images. The volumetric analysis herein is to determine the vertices of the surface of the 3D object in a 3D space. The vertices of the 3D object define a volumetric boundary of all the volumetric cells in a 3D space so as to define the 3D region.

7. The following paragraph replaces the original paragraph that begins line 14 and ends line 20 of page 27 of the Specification:

A space carving process is devised to perform the volumetric analysis. Intuitively, a 3D object is assumed to fit within a single cube in a 3D space. The single large cube now needs to be carved gradually in order to fit the object properly. The carving process starts with subdividing the cube into smaller cubes and compares each of the smaller cubes with each of the mask images. The resultant carved model is referred to as a 3D region of the object.

8. The following paragraph replaces the original paragraph that begins line 4 and ends line 10 of page 30 of the Specification:

It may be understood that the "gray" cubes may be caused by the boundary of the object and shall be further divided up to a predefined degree of refinement to decide the boundary. The same procedure can be recursively applied until the cubes are subdivided up to the refinement, then the collection of "black" cubes defines a

volumetric boundary of an [exemplary] object in a 3D space[as shown in **Figure 6C**].

9. The following paragraph replaces the original paragraph that begins line 23 of page 32 and ends line 14 of page 33 of the Specification:

The rest of the process at **868**, **872** or **874**, **876** and **878** are similar and have been described above. However, when the last line of a mask image is done, the process will branch out from **878** to **880** to decrement j by one to move to a line above and starts at **856**. Then the process continues along the line [un]till the very first pixel is processed. What is important here is the [judgement]judgment at **860**. The process checks if the neighboring encoded values correspond to the same color (either the background or the foreground) as the pixel at (i, j) of the mask image. If one of the neighboring encoded values is not the same, the encoded value will be either 1 or -1, otherwise it will be just an increment of the smallest value among the absolute value of the neighboring encoded values, for example, among the neighboring encoded values 2, 3 and 4, the smallest value 2 is incremented to 3, or among the neighboring encoded values -2, -3 and-4, the value (–2) is incremented to (–3). It can be appreciated that the computation of the process increase linearly in the number of pixels in the mask images.

10. The following paragraph replaces the original paragraph that begins line 1 ends line 21 of page 51 of the Specification:

The advantages of the invention are numerous. Several advantages that embodiments of the invention may include are as follows. One of the advantages is an economical and efficient 3D modeling system that is low in cost and easy to operate, virtually anywhere within minutes. The modeling system employing the present invention can be used and operated by an ordinary skilled person to generate fully-textured models of 3D objects within a limited time for many applications including Internet commerce and product designs. Another advantage is the MAE scheme that encodes all mask images to make the space carving process nearly independent of the size of images. Still another advantage is the process of generating a mesh model using neighborhood configuration that produces only valid

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triangles. Still another advantage is the texture mapping process that provides a mechanism to generate exportable patches comprising triangles that can be provided contiguous texture mapping without user intervention. Yet another advantage is the possible implementation of the texture mapping processing on graphics accelerator architecture to [redirecte]redirect the graphics accelerator to draw into a buffer in memory rather than the buffer for a monitor, yielding a much more efficient mapping of the textures.

In the Claims

Please amend Claims 1, 6-7, 18, 23-24 as follows:

1. (*Amended*) A method for automatically generating a fully-textured 3D model of an object[;], said method comprising:

receiving from a camera a sequence of images taken sequentially and respectively around the object;

generating a 3D region from a sequence of mask images[;], each of said mask images derived from one of said sequence of images by projecting the object onto a specific plane;

generating a mesh model from said 3D region using a tree structure; and

producing said fully-textured 3D model from said mesh model with respect to said sequence of images.

6. (*Amended*) The method as recited in claim 5[;], wherein each of said cubes is encoded as a node in said tree structure that grows, while said carving said cubes recursively proceeds, till a predefined degree of refinement.

7. (*Amended*) The method as recited in claim 6; wherein said generating a mesh model comprises:

collecting all leaves of said tree structure by traversing said tree structure,

determining boundary cubes from said leaves; and

triangulating a group of at least three of said boundary cubes according to predefined rules.

18. (*Amended*) A computer readable medium for storing computer program instructions for automatically generating a fully-textured 3D model of an object[;], said computer readable medium comprising:

first program code for receiving from a camera a sequence of images taken sequentially and respectively around the object;

second program code for generating a 3D region from a sequence of mask images[;], each of said mask images derived from one of said sequence of images by projecting the object onto a specific plane;

third program code for generating a mesh model from said 3D region using a tree structure; and

fourth program code for producing said fully-textured 3D model from said mesh model with respect to said sequence of images.

23.(*Amended*)The computer readable medium as recited in claim 22[;], wherein each of said cubes is encoded as a node in said tree structure that grows till a predefined degree of refinement.

24. (*Amended*) The computer readable medium as recited in claim 23[;], wherein said third program code comprises:

program code for collecting all leaves of said tree structure by traversing said tree structure,

program code for determining boundary cubes from said leaves; and

program code for triangulating a group of at least three of said boundary cubes according to predefined rules.

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